REMARKS/ARGUMENTS

Favorable consideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 15, 18, 20 and 21-25 are pending in the application, with Claims 15, 20 and 21 amended and Claims 22–25 added by the present amendment.

In the outstanding Office Action, the specification was objected to; Claims 15, 18, 19 and 21 were rejected under 35 U.S.C. § 112, first paragraph; Claims 5, 18, 19 and 21 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Vives; Claims 5, 18, 19 and 21 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Radjai et al. and further in view of Vives.

Applicants acknowledge with appreciation the personal interview between the Examiner and Applicants' representative on March 30, 2005. During the interview, the Examiner acknowledged that support for Applicants claimed shifting of particles to an end portion is found in Applicants' originally filed specification at page 11, line 7 and page 14, line 12.

The specification is amended as requested in the Official Action.

Claim 15 is amended to more clearly describe and distinctly claim Applicants' invention. Claims 20-21 are amended to maintain antecedent basis. New Claims 22-25 are directed to additional features of Applicants' invention. Support for these amendments is found in Applicants' originally filed specification.[1] No new matter is added.

Radjai discloses a method where "Vibrations were induced in a hyper-eutectic Al-Si alloy containing suspended silicon particles and the effects were studied" and that "Suspended silicon particles multiplied in number with a reduction in size by vibrations at temperatures higher than the liquidus and agglomerated and repelled to the outer surface after

[1] Specification, page 12, line 13; page 15, lines 14-15; and page 10, lines 22-23.

the start of solidification". In the method of Radjai, a molten hyper-eutectic Al-Si alloy which contains suspended silicon particles added thereto is used as sample. The Al-Si alloy is heated to produce molten state of alloy, with solid silicon particles added thereto, and then electromagnetic vibrations are applied to the alloy to multiply the suspended silicon particles in number. Thereby the particles are agglomerated so as to be enlarged and repelled to the outer surface where the resistance against the macro-flow is smaller. Thus, Radjai does not disclose "vibrating the solidifying molten metallic material by applying an alternating electric current and a magnetic field simultaneously at a current value and a Tesla value configured to crush solid crystal particles of the solidifying metallic material into small pieces."

Radjai also fails to disclose Applicants claimed "shifting the small pieces to a periphery of a cylindrical tube or container with said alternating current and said magnetic field set at a current value and a Tesla value configured to concentrate said refined microstructure of the metallic material in the periphery of the cylindrical tube or container" for the following reasons:

- In Applicants' claimed invention the refined particles are shifted by a "pinching force" generated by the interaction between the magnetic field and the alternating current so as to be unevenly distributed at the periphery of a container. The pinching force generated by Applicants' claimed invention acts against a center of radius of the sample of the molten alloy and against small particles produced previously. However, the small (e.g., silicon crystal) particles have a lower electric conduction and thus accept a smaller pinching force compared with the molten alloy. Thus, the small particles are shifted to the periphery of a container due to the difference between the pinching force applied to the metal and the pinching force applied to the crystal particles. As with Radjai, macro-flow effects may be generated as well. However, with Applicants' claimed method, the flow resistance of Applicants' small particles is

less than the flow resistance of the agglomerated and enlarged particles produced by Radjai. Therefore, Applicants' small particles are not repelled to the outer surface but are unevenly distributed at the edge portion of the sample. Further explanation of the difference between "repulsion" and "shifting" is shown in Fig. 2 attached hereto.

- In Radjai, the suspended silicon particles remain solid state in the molten alloy, whereas in the present invention, the completely molten alloy is cooled to solidify the sample (see Fig. 1 attached hereto). Thus, for another reason, the particles generated in the present invention are smaller than the silicon particles produced by the method of Radjai, further facilitating Applicants' claimed shifting.

Vives discloses a magnetohydrodynamic method for transmitting forced vibrations to solidifying aluminum alloy. Vives notes that "the magnetohydrodynamic phenomena occurring during the tests are rather complex and will not be thoroughly examined."[2] The reference goes on to note that the purpose of the study is "restricted to the presentation of the main characteristics of the fluid flow in an attempt to follow the evolution of both the size and shape of the grains during solidification." For the following reasons, like Radjai, Vives fails to disclose or suggest Applicants' claimed step of "shifting the small pieces to a periphery of a cylindrical tube or container with said alternating current and said magnetic field set at a current value and a Tesla value configured to concentrate said refined microstructure of the metallic material in the periphery of the cylindrical tube or container."

In Vives, an electric current and a magnetic filed are simultaneously applied to a metal sample in a vessel having free surface (i.e., a vessel without a cover).[3] Because of this free surface, the previously described pinching force cannot be successfully generated. Also, even if a reduced pinching force were to be generated in the vessel, the pinching force will be scattered and lost through the free surface. On the other hand, with Applicants' claimed

[2] Vives, page 446, right column, in the paragraph beginning on line 22.
[3] Vives, Figure 3.

cylinder by definition has no "free surface." Thus, Applicants applied electric current and magnetic field can generate the previously described pinching effect, resulting in Applicants' claimed step of shifting.

Furthermore, the vessel used in Vives is made of stainless steel. Thus, some of the electric current of Vives passes through vessel itself to produce Joule heat which cases great loss of the electric current impressed. Furthermore, induced magnetic field for generate pinching force is absorbed to the stainless steel of the vessel and thereby pinching force can not be generated. Also, in Vives the strength of the magnetic field in Vives is about 1/10 compared with that of the present invention. Therefore, the effect of the magnetic field is greatly different between Vives and the claimed invention. That is, in the claimed invention, the electric field and magnetic field act to apply electromagnetic vibrations to the molten metal at a magnitude sufficient to cause the "shifting" of the metal particles. Applicants' claimed "shifting" cannot occur with the stainless steel vessel in Vives and with the low power magnet of Vives.

Finally, the shape and materials of the container or vessel are very important elements to generate Applicants' claimed "shifting." For ease of understanding, Figure 3 of this paper shows Applicants' claimed cylindrical metal sample inserted in an insulated container made of ceramics or glass. This sample is melted, subjected to electromagnetic vibrations, and solidified to produce refined metal particles. The electromagnetic vibrations and previously described pinching force act against the metal particles to shift the initial crystallized silicon particles in the container to the surrounding walls.

As seen in Figure 4 of this paper, in Vives a metal sample is inserted in a rectangular container with open upper part (free surface) made of stainless steel. This sample is melted, subjected to electromagnetic vibrations, and solidified. The electromagnetic vibrations of

Vive act on the metal sample. However, the generated pinching force escapes from the open upper part of the container. Thus, "shifting" of the metal sample does not occur.

MPEP §706.02(j) notes that to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. Also, the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck,* 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Without addressing the first two prongs of the test of obviousness, Applicants submit that the Official Action does not present a *prima facie* case of obviousness because both Radjai and Vives fail to disclose all the features of Applicants' claimed invention.

Accordingly, in view of the present amendment and in light of the previous discussion, Applicants respectfully submit that the present application is in condition for allowance and respectfully request an early and favorable action to that effect.

Respectfully submitted,

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